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6. VIRTUAL GAMES AND CAREER EXPLORATION

A Case Study of Appalachian Schools

INTRODUCTION

The US National Science Foundation (NSF) estimates the shortage of those entering the engineering field will reach over 70,000 this year. Given the shortage of engineers and scientists entering the STEM fields, efforts must be made to encourage students to seek these careers during the early years of middle school and high school. In a recent survey conducted by the American Society for Quality (ASQ, 2009), it was found that "both male and female students are not interested in the field of engineering because they don't know much about it (44 percent); they think they would prefer a more exciting career (30 percent); and they don't feel confident enough in their math and science skills (21 percent)." (Weinstein, 2009, "Are Parent Attitudes Keeping Girls from Science Success?", para. 3).

The STEAM (Science and Technology Enrichment for Appalachian Middle-Schoolers) project at Ohio University has developed an educational game engine called STEAMiE. The engine is being used by engineering students and educators to develop science games targeting middle school classrooms hoping to foster a strong foundation in the STEM areas of science, technology, engineering and math which is critical for future leaders of society. Middle school students are at an age in development where they are beginning to think about educational careers.

Gottfredson (1981) explains that students start exploring and comparing career paths in an abstract way during middle school. Developing an interest for a specific career is a learning process where students often build relationships with people in their school and community and associate the information that they obtain with various career fields (Koszalka, 1999). As Koszalka (1999) explains, in order to stimulate interest in certain jobs, a hands-on interactive approach is needed. Unfortunately, in areas like Appalachian Ohio, USA, few examples exist for science-based careers within the communities that make up this rural and isolated region.

Lacking exposure to the possible career opportunities, middle school students are often unaware of the possible futures in STEM fields. The specific skills required for by corporations, industries, and other hiring entities are often not sufficiently developed in poor, rural areas. Career Exploration is an educational game created by STEAM to provide an interactive experience for the middle school science students. The game is an opportunity to address the problem of career education in

M.S. Khine (ed.), Playful Teaching, Learning Games: New Tool for Digital Classrooms, 87–105.

areas where knowledge of professional science employment is lacking. This chapter seeks to share the impact obtained from the use of a virtual game called Career Exploration in the promotion of STEM careers. Multiple difficulties in bringing games into the classroom and a review of past attempts to expand knowledge of science careers to middle school student will be presented as well as survey data and pre/post testing as well as a discussion of game development and implementation in middle school.

DEVELOPING AN INTEREST IN SCIENCE CAREERS

It is tantamount to apprehend the underlying science principles and theories if one hopes to have a successful STEM career. On the basis of a career path, science literacy is on the decline in the United States. After studying 90% of the world's economic activity regarding science literacy, the Organization for Economic Co-Operation and Development (2007) stated that science literacy in the United States has dropped over the last 15 years. According to the study, they say that the United States ranks statistically below average in terms of testing 15 year old science students. It has been recommended that the United States needs to improve interest in youths to remain a global leader of economic development and political power. Studies have also shown that minorities' do worse than white students in the United States.

Catsambis (1995) suggests that minority groups are more positive and more interested in science knowledge. Even though minority groups tend to be more positive, they also tend to score lower in preexisting science knowledge than other groups. Catsambis (1995) reported that males tended to perform lower than females on scientific knowledge tests. Catsambis also noted that males are more interested in science career paths typically than females. Thus, it is important for a countries' development to interest and engage females as they make up 50% of the population.

To increase STEM interests, the National Science Foundation (NSF) has supported many projects with a focus on engaging younger learners in math, science, technology and engineering. The NSF funded project, Bringing-Up Girls in Science (BUGS), has a primary focus of investigating methods to increase the interest females have in science. It was found that to increase enthusiasm, confidence, and science skills, the pairing of primary school females with mentoring high school females was beneficial (Goforth, 2005). The NSF funded the project, Design Squad, to use a hands-on approach for students aged 9–12 (National Science Foundation, 2007). The Design Squad project involves students in a science activity by involving students in real scientific research (Hansen, 2004). The projects, Hands-On Universe (http://www.handsonuniverse.org/index.html) and Whale Net http://whale.wheelock.edu/Welcome.html), are also using hands-on interaction to teach science.

The Hands-On Universe project has involved 300,000 students to explore stars in the universe. As the name implies, the Whale Net program brings together students to work with whales and other animals to look into diving patterns and other oceanic research. One of the leading mediums for increasing science awareness regardless of genders and ethnicities is the television. The project, Foster Children's Interest in Science, (Mares, Cantor, & Steinbach, 1999) examined the correlation of television

programs and young adults in science perception. Mares et al. argues that television increases scientific-enthusiasm in addition to teaching science content.

Interest in science careers can be motivated by using the method of literature circles (Straits & Nichols, 2005). A literature circle assigns different roles to the students. For example, the students can be assigned the roles of a discussion director, illustrator, summarizer, and a science translator. Focusing on text or topics, these circles benefit the children involved by having each child choose his/her own reading material difficulty level for the activity. In general, this freedom of participation leads to increased understanding of the reading material and thus a better level of understanding about science career paths.

Often science professionals are used in the classroom to increase science awareness. This is an effective way to engage the student audience by inspiring the students through lessons related to the professional's chosen career path. Unfortunately, it is difficult to find professionals to come into the classroom and share their related science careers. An alternative is if the science professionals can't come to the classroom; take the classroom to the professionals. Field trips and tours are very popular and usually successful because the students experience settings the classroom cannot provide. Unfortunately, these field trips are often prohibitively expensive. With today's technological advances, students are able to experience virtual field trips through new digital media. Keeping the students physically in school reduces cost while keeping the students engaged in various online activities, pictures, and videos. To this end, the Career Exploration game aims to engage the students in multiple science careers while maintaining a low technological barrier of entry.

STEAM BACKGROUND

The STEAM project consists of graduate students and faculty members from the College of Education and the Russ College of Engineering and Technology at Ohio University. STEAM has two primary goals. First, the project seeks to broaden graduate education and experience by pairing graduate students with middle school science teachers. The teachers are considered 'content-experts' while the graduate students are the 'technology-experts'. It was the task of the graduate students to implement games based on the science concepts developed by the teachers and required state testing. The GK-12 Graduate Fellows (referred to as Fellows here forward) visit the schools during the academic school year and interact with the students. This improves the communication skills by having the Fellows assist the middle school science teachers during regular classroom sessions, lead computer lab time, and relate the graduate students' research to the students. Most electronic media is brought into the classroom through the educational computer games created by the Fellows. Fellows created games that were used to teach 'difficult-to-teach' concepts identified by the middle school science teachers and the Ohio Department of Education. The games had to adhere to the content outlined by Ohio's Academic Content Standard for Science (http://education.ohio.gov/GD/Templates/Pages/ODE/ODEDetail.aspx?page=3&TopicRelationID=1705&ContentID=834&Content=72481).

The project's second goal was to improve the middle school students' scientific content knowledge, skills, and achievement. By having the Fellows in the classroom,

both goals were met and a mutual, beneficial relationship was developed between the STEAM Fellows and the middle school faculty and students. The educational benefits provided by the project to the Appalachian schools were important in part because of the multiple socio-economic difficulties facing the school districts in this rural region.

ISSUES IN THE IMPLEMENTATION IN SCHOOLS

There are multiple challenges that must be overcome to successfully bring together classrooms and digital media especially when the digital media is within a virtual environment requiring bandwidth and internet access. The start of the game design process began with professional development sessions lead by the faculty team of the STEAM GK-12 project. The professional development sessions shared with middle school science teachers and graduate students how to successfully bring digital media into their classrooms and design lessons that not only met science content standards but actively engage the learner in the web-based game and content. The middle school science teachers focused on what science content must be within the games to best help their students learn difficult science topics. What was learned in the professional development was that teachers are often reluctant to acknowledge their own lack of understanding of a specific content area. There was a need for the university faculty to at times step in and suggest science topics for consideration in the game design in which students of the participating teachers had not scored well on the state test. Teachers had a tendency to develop content within games that they had mastered. Much discussion was conducted within the professional development sessions on the need for teachers to continue to learn new content and that such learning would also improve the science scores of the their students on the state tests. STEAM found similar findings as McFarlane, Sparrowhawk, and Heald (2002) when dealing with teachers and the use of games in the classroom. Overall, STEAM found that teachers had difficulty:

1. Determining the relevance of a game to the curriculum,
2. Convincing principals that games might improve student learning
3. Using the technology when games were played in the classroom and were often unable to troubleshoot
4. Identifying content in the game that was incorrect or that hindered learning,
5. Planning how the game would be used within a lesson to support the content being presented in the typical lecture setting that most of the teachers used.

It was the task of the Fellows to make sure the ideas of the teachers were technically feasible. Even if an ideal game was conceived, problems and limitations of the computer hardware available in economically challenged Appalachian schools could hinder or change the way game development occurred. Computer technology changes rapidly allowing for major advancements in web-based content but budget conscious schools often have older computer hardware and less internet access making them incapable of working with the virtual content of a game. Because of this, the games created by STEAM had to be designed to be problem free in both high and low technology environments. No matter what hardware and software issues

may arise in a school, the goal was to create fun, engaging, and educational science games that improve teaching and learning in the middle schools in rural areas. This was often a difficult task but only through overcoming hardware, software, and internet access challenges could an effective teaching tool be created that was be delivered across the internet to access learning both in the school setting and online in after school hours by the STEAM schools.

STEAM AND SECOND LIFE

Studies have suggested that students learn better from 3D game environments that use cooperation and or competition to encourage the players (Shaffer, Squire, Halverson, & Gee, 2005). It is believed, by these researchers, that games developed in 3D turn passive learners into active learners thus increasing the comprehension of the educational topics covered in the games. This suggests that 2D games developed in Flash are not as effective learning tools compared to 3D games (Young, Peng, Carroll, Franklin, Lui, & Chelberg, 2009). One of the 3D environments used by STEAM and one of the first such environments used by STEAM was Linden Lab's Second Life (Franklin, Mayles, Chang, & Chelberg, 2007). Every player in Second Life controls and avatar or virtual representation of themselves that is unique and capable of interacting with the virtual world around them. Development time in Second Life was shortened because of its easy C-like scripting and Second Life's handling of camera, chat, networking, and other necessary game aspects. In addition to the expertise provided by Linden Labs, a large, helpful community has developed around Second Life providing scripts, world objects, and online tutorials that can assist in quick development of games. For all of its benefits, Second Life was not without its problems when implemented in schools. The biggest problem encountered by STEAM was the requirement of a high-speed internet connection by Second Life to access the servers. Schools in rural areas did have access to the internet but this access was shared by the district office and others that often made large data upload to the Department of Education. These uploads were not carefully scheduled and the bandwidth was reduced to the point where an avatar in Second Life was unable to move within the environment. A second challenge to using Second Life was the need to open a port to access the software on the Linden Labs server. This allowed for a possible breach in the security of the school's server and technology coordinators and principals were reluctant to allow any access to the closed system of the school server in fear of data breaches that might compromise confidential student data. The liability of a data breach in student data prevented the use of Second Life in schools with limited security skills for dealing with port issues. Finally, the computer labs in the middle schools often had poor networking capabilities, electrical problems in which turning on all computers would overload the circuit, and/or computers over five years of age without adequate operating systems for virtual software. These problems set the stage for the development of a more flexible virtual gaming environment that could negotiate the issues found in schools in a more productive way than Second Life. This software engine developed by the Ohio University faculty and Fellows came to be known as STEAMiE.

IMPLEMENTING STEAMIE

The limitations of Linden Lab's Second Life forced STEAM to develop an 'in-house' educational game engine called STEAMiE (Nykl, Mourning, Leitch, Chelberg, Franklin, & Lui, 2008). STEAMiE is a cross-platform engine that supports dynamic lighting, high fidelity physics, high resolution graphics, networking, event driven controls, and multiple other sophisticated devices that allow connectivity between online question sets and high score systems. STEAMiE has been designed with the intention of running on modest computers and being suitable for school settings having a wide variety of technological factors. It should be noted that even with the challenges identified with teachers, and schools, STEAM has proven it possible to create and evaluate educational games to teach Ohio's Content Standards for Science (Franklin, Chelberg, & Liu, 2009).

IMPLEMENTING THE CAREER EXPLORATION GAME

To address the issue of increasing awareness of science careers among middle school students STEAM developed the game Career Exploration in STEAMiE. The Career Exploration game introduces students to many science careers in a fun, interactive, and educational way. The careers showcased in the game broaden the typical middle-schooler's perception of science jobs. The game has the goal of reinforcing why science knowledge is important in a wide variety of careers.

THE CASE STUDY

Students have trouble understanding why they are learning science concepts in the classroom. Often, students do not see how science relates to their career choice and little is being done to address this issue. Career Exploration attempts to show middle school students that science knowledge relates to a wide variety of professional careers. The concept that science can be used broadly is introduced to the students in a fun and entertaining way through different careers that they typically do not have experience with. The STEAM project involves multiple graduate students and working professionals in many difference career fields. Utilizing these differences, Career Exploration teaches students that a science career can be both meaningful to society and enjoyable to the working professional. This is accomplished by having the students explore a 3D world in Career Exploration that has students overcoming obstacles in a virtual car race to unlock images of members from the STEAM project. After an image is unlocked, students must read the bios of the STEAM members represented by the images. By reading these bios, which contain descriptions of the related job, summaries of past projects, and advice for higher education, the middle school students are introduced to new career paths.

THE SETTING

Students within this study are located in Southeastern Ohio in the poorest rural county in the state of Ohio, USA. Thirty-nine students and 1 teacher participated in

the study. Approximately 46.6% of the students in the school qualify for free and reduced lunch. The student data indicates the school has been designated as in Continuous Improvement, only meeting four of the ten required state indicators for school quality. The state report card for the school notes that it has not yet met AYP (Adequate Yearly Progress) which is determined by No Child Left Behind (NCLB) established by the US Department of Education. The eighth grade science score was 58.7% of a possible 100%. The school is predominately white, non-Hispanic with 23.2% of the students identified as a student with a disability (http://www.ode.state.oh.us/reportcardfiles/2008-2009/DIST/045906.pdf).

The research team consisted of two graduate students from the Russ College of Engineering and Technology at Ohio University and Fellows in the STEAM project and two faculty members from Ohio University, one from engineering/computer science and one from technology education. The participants were eighth grade students and their middle school teacher all of which had participated in the use of games in science in the past. They were familiar with the use of games within content delivery and had worked with the STEAM Fellows as well. This provided a comfort zone for the use of the Career Exploration game as the students had worked in other virtual environments before and had the needed technology skills for moving around in this type of space and encountering information in this format. Parental release forms were collected from each student and teacher participating in the research.

THE PILOT

Career Explorations was piloted in 2009 to determine issues surrounding usability, understanding of the terms within the games and whether the game might hold a student's attention within a classroom setting. The worksheet developed to accompany the game was also piloted to see if the questions on the worksheet actually captured the information from the game. Changes were made to the game after it was played at a middle school for the pilot study. The amount of changes made to the game was moderate. Most of the students requested that the virtual automobiles handled differently in the game. Time was spent on this issue to stop the cars from flipping over as easily. Students wanted an easy way to navigate through the five courses in the game. Buttons (see Figure 9 on following pages), were added and allowed students to "jump" form one course to the next after completion. Students indicated that they should be able to play certain courses again. Certain objects in the game (see Figure 3 on following pages), were repositioned to allow students to replay Career Exploration's obstacles. The worksheets that the students work on while playing the game underwent the majority of the changes after the pilot study. Initially, students had some difficulty finding certain biographies to answer the questions in a timely fashion. To correct this problem, students were told on which course a certain biography could be found. Course banners (see Figure 5 on following pages) were added to the game as well. Among the worksheet changes, the worksheet was split up into two parts. The first worksheet was designed with ten questions which required the students to read the material presented in the biographies while playing the

game in class. The second worksheet was designed to be a homework assignment, where specific questions about the biographies are not asked and student research was required.

THE CAREER EXPLORATION GAME DESIGN

A set of instructions were presented to the students as they first launched the Career Exploration software as shown in Figure 1 and Figure 2. It is important that easy-to-read and easy-to-understand instructions accompany any educational game. Students often do not have the patience or capability to read lengthy documentation before attempting to play the game. When confronted with complicated directions, students will often skip the instructions and attempt to play the game without need knowledge for maneuvering or locating information within the game. Though some students are quite successful playing the game based off their gaming-experience or trial and error experience, others struggle and the game's ability to teach is hindered. Career Exploration offered a set of instructions that were easy to read and understand as well as providing a set of controls that were intuitive to most all gamers. Students enjoyed having a choice of the type of virtual automobile they controlled during the game as shown in Figure 2. This excitement of having choice within the game was seen in STEAM's Second Life games, where students had almost limitless control of what their avatars looked like. This choice feature in the selection of cars came out of earlier research by STEAM. The selection of a race type environment was also identified through previous research by STEAM and confirmed in the literature by the PEW Internet & American Life Project (2008) which showed that teens from families making less than $50,000 a year play often games related to racing. This information became an important factor in creating games designed for the Appalachian area. It was theorized that this type of engagement helps students become immersed in the digital content and the immersion creates a more conducive environment for learning.

Figure 1. Game introduction (Young, Flores, Franklin, Chelberg & Chang, 2009).

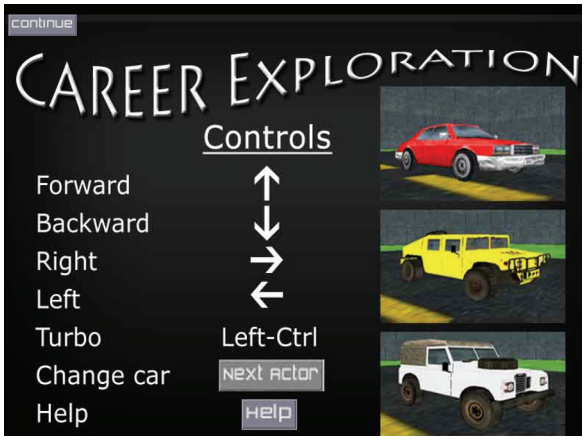

Figure 2. Car controls (Young, Flores, Franklin, Chelberg & Chang, 2009).

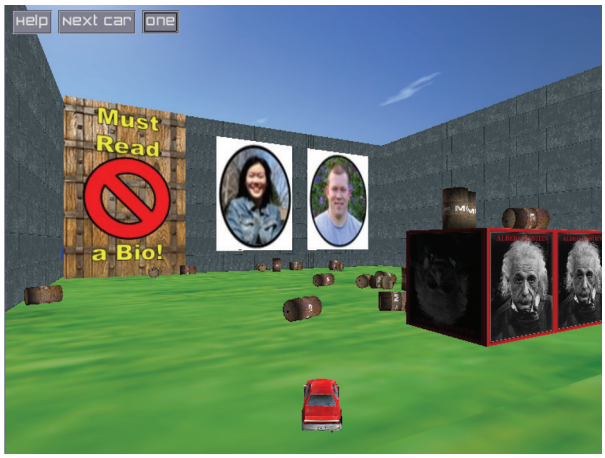

Figure 3. Einstein's barrels (Young, Flores, Franklin, Chelberg & Chang, 2009).

The first course in Career Exploration requires players to drive a car off a ramp and to crash into a set of barrels that are hidden underneath the first set of red spheres. These spheres are called "waypoints" and they represent the objective of how each course is completed. Once a car goes through a waypoint, images of STEAM members appear on the walls of the course as shown in Figure 3. With a simple mouse click, students are able to read biographies constructed by the diverse set of engineering, science and educational majors that have worked on the STEAM project. The biographies contain a multitude of information for the students to read that contain a definition of their career specialty, a description of a science projects that they have worked on in the past, advice about higher education or their personal

career path, and their favorite quotes about science. For example, Figure 4 shows a computer science biography for Scott, a GK-12 Graduate Fellow. In his biography, Scott talks about his experience working for Airbus as a Master's student and offers insight as to why he was drawn to computer science and what he enjoys most about the field. Most of the biographies that appear in Career Exploration have personal pictures that are used to help explain various topics that are discussed by the project members. The pictures help the students connect and remember key career concepts.

Career Exploration uses a set of locked doors to separate its five courses as shown in Figure 3. To unlock the doors, students must read the biographies before moving on to the next obstacle. Students cannot ignore the educational piece presented in the game before having fun. Different challenges are presented to the players in Career Exploration. For example, Figure 5 shows the third course in the game where students maneuver across a bridge of swinging pendulums. If a car is hit by a swinging pendulum, it is knocked off the bridge and the player must restart the obstacle. Another course that appears in the game utilizes a conveyor belt that is shown in Figure 6. To complete this obstacle, students must avoid falling apples from the sky while controlling the car across a bridge without falling through the holes along the conveyors belts that move at different speeds and directions.

Making games challenging for the students has proven to be a key design concept for educational games developed by the STEAM. Students have noted to the researchers a sense of accomplishment from overcoming a difficult task that helps maintain their focus and desire to learn from the games. Although, an overwhelming number of students participating on the STEAM project demand challenging games, a portion of the students lack the motor skills and cognitive ability to complete these tasks which brings another important design concept that is critical to the development of games for schools. STEAM Fellows had to design educational games that were suitable for all ability levels. In Career Exploration, a timer is used to unlock the pictures on the

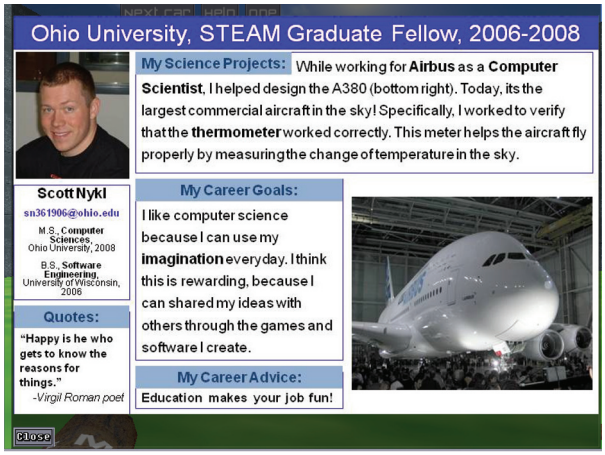

Figure 4. Computer science biography (Young, Flores, Franklin, Chelberg & Chang, 2009).

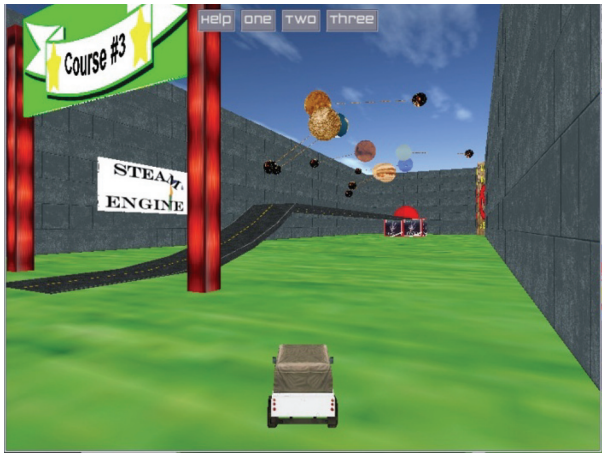

Figure 5. Shepard's pendulum bridge (Young, Flores, Franklin, Chelberg & Chang, 2009).

Figure 6. Newton's conveyor belt (Young, Flores, Franklin, Chelberg & Chang, 2009).

wall after a predefined time. This allows students of all ability ranges to complete the game even if they cannot complete the challenges first presented to them in through the challenge of unlocking the doors within the digital environment. When the game is implemented in the classroom, time is a limiting factor. Timers help to maintain the students' pace so they can finish the game in a class period even when hand-eye coordination or limitations present themselves.

Career Exploration primarily hosts biographies related to the field of engineering, science and science and technology education. In terms of engineering, the game

presents biographies from the major disciplines that includes mechanical, electrical, civil, computer science, industrial and systems engineering, and computer science. One important feature that the game incorporates is a variety of biographies from female engineers and educators including biographies from a variety of nationalities. For example, Tessa, a graduate student in computer science, is shown in Figure 7. In Tessa's biography, she explains how she is developing software that will help patients with diabetes. As Peng noted, there is a "stereotype that science is a male-dominated profession" (p. 43). Career Exploration provided bios of males and females with strong science backgrounds and used "gender-equitable instructional strategies" (p. 41) to provide unbiased instruction (Peng, 2009).

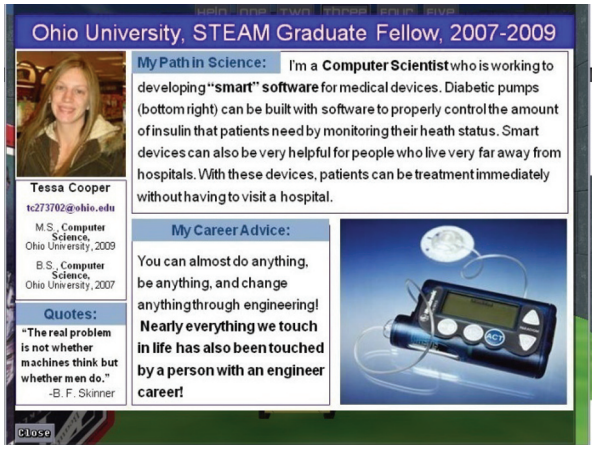

Figure 7. Women in engineering (Young, Flores, Franklin, Chelberg & Chang, 2009).

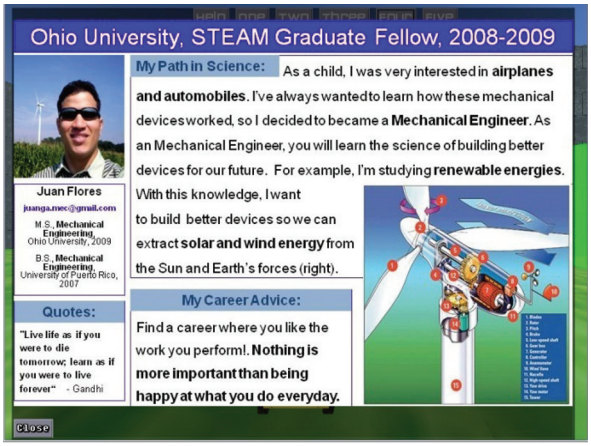

Figure 8. Various ethnic backgrounds (Young, Flores, Franklin, Chelberg & Chang, 2009).

In terms of ethnic backgrounds, Career Exploration contains biographies written about people from countries that include Taiwan, China, Puerto Rico, and the United States. Figure 8 presents a biography about Juan Flores, who is a Hispanic graduate student in mechanical engineering. In his biography, he talks about his desire and inspiration to study renewable energies as a career choice. Biographies such as these are intended to inspire the students by showing them people from a wide variety of backgrounds, ethnicities, and cultures that have been successful in science-based fields.

When students complete the first four courses in Career Exploration, they are rewarded with a trophy based on the number of biographies they have read, as shown in Figure 9. Students love competition, so it should be integrated into educational games when feasible. Whenever possible, a scoring system should be built into educational game that rewards students for completing tasks and answering questions based on the educational centerpiece of the game.

Students are not asked questions directly in Career Exploration. Worksheets have been designed to reinforce the topics contained in the presented biographies. For example, Figure 10 shows eight grade students playing Career Exploration in class. The worksheets attempt to make sure all ten biographies are read in the first four courses. Students are asked a variety of questions pertaining to the biographies. For example, they may be asked about a specific career task, why a certain task is important to society, or other questions related to the quotes and advice that was presented in the biographies. Time dedicated to teaching students about science careers is often limited in the middle school setting. The game and worksheets that are used must consider this limiting factor when developing digital forms of media for the classroom. The worksheets that accompany Career Exploration are organized in the specific order that the biographies appear in the game. Seeing those involved in STEAM in Career Exploration changes how the middle-school students view science careers (Peng, 2009).

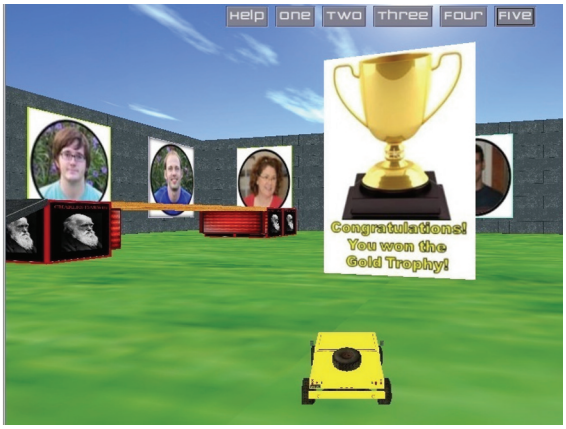

Figure 9. Career exploration trophy (Young, Flores, Franklin, Chelberg & Chang, 2009).

Figure 10. Student (Young, Flores, Franklin, Chelberg & Chang, 2009).

FINDINGS

When Career Exploration was implemented in this study, revisions to the game and worksheets had occurred. The worksheets were created for the students to work on while they played the game. The worksheets contained ten questions about the biographies that the students read about in the game and three extended questions. The purpose of these questions were to determine how well the students like the game, and to determine what they learned by playing it. The responses of these questions were used also as a means for improving the game. Three open-ended questions were added to examine the overall introduction of science careers and satisfaction of the game. The three questions were:

1. What career path in science excited you the most in the game?
2. What career path in science were you not previously aware of before playing the game?
3. Did you like playing Career Exploration? What did you learn about careers in science? Please explain.

The responses varied for the questions asking the students about which career excited them the most. Many of the students wrote about how civil engineering intrigued them the most, which was surprising, as only one biography was dedicated to that particular discipline. This response could have been attributed to the students' living in the rural area of Appalachian Ohio, where many students enjoy outdoor activities such as hunting, fishing, and hiking. In their response, students expressed their desire to "help society coexist with our environment." In a related field, students wrote about meteorology. STEAM's Project Manager's bio discussed being a Weather Control Officer for the United States Air Force. This biography excited students by describing job duties as helping engineers to design jet fighters and studying the weather to determine if certain missions would take place.

Students also wrote about how they would like to become computer scientists. This was not surprising because the majority of the biographies featured this field of study. In these biographies, STEAM Fellows expressed their desire to work for a video-game developer or service-based entities that would benefit from software development. It was expected that many students would write about careers designing and developing video games for a living. However, it was surprising to see how many students wrote about how they would like to develop 'smart' software for the medical community.

Students often have a limited view of potential career duties. Thus, it was interesting to read the responses to the second question that asked about which careers they were not aware of before playing the game. Many students thought they were familiar with the electrical engineering discipline. However, they were surprised to read about the tasks that the STEAM members wrote about in their biography. For example, many of the students thought electrical engineers were limited to repairing radios, televisions, and other household electronics. Thus, students wrote about the various tasks such as developing electronic navigation systems for this question. Students of the same students that wrote about civil engineering exciting them the most were the same student who wrote about not being familiar with the specialty before playing the game. Many students described how they though civil engineers were "people who built bridges," but later wrote about how they also "work with the environment to make our lives better." These types of responses reinforced that the students were able to learn a deeper understanding of the profession that were described in the game.

The last question of interest regarded their likeability of the game and asked them more specifically what they learned by playing Career Exploration. In general, most all of the students liked participating in the "difficult challenges." However, a few (n = 7) of the students remarked that the game was "too hard to play," but also noted that they "learned a lot about careers." It was important to design Career Exploration for the variety of skill levels in the middle-school setting. The comments for the final question were nearly all positive; some of the quotes obtained from the worksheets are presented below:

> *Yes, for playing it because I love games! Yes, I learned because their information was straight to the point and the game format made me want to keep playing. [S16]*

> *Yes, I liked playing Career Exploration. Yes, I did learn more about careers in science because each person told us different things about their jobs. [S37]*

> *Yes, because I got to try something new and it was fun and challenging. Yes, because we got to learn about new careers and more about the ones I already knew about. [S22]*

> *Yes, because I had fun while I was learning. I learned that science careers can be fun [S21]*

A pre and post interest survey was used to examine if changes in science interest. The survey was developed and modified with permission from a survey created by the

Physics Education Research Group at Colorado (2004), Colorado Learning Attitudes about Science Survey. The pre-survey was given 2 weeks before the Career Explorations game play. A post survey was given 3 days after the game play. The delay in the post survey data collection was planned in hopes of negating the Hawthorne effect that may come from game play. Table 1 reflects the data from a t-test and the mean differences from the pre/post data.

As the table shows, there was a statistically significant difference in the t-test value and the means of the pre/post tests indicating the Career Exploration game was able to influence changes in student interest surrounding careers in science.

Table 1. Pre/post test of career explorations (N = 39)

	t	*Sig. (2-tailed)*	*Mean difference*	*Std. error means*
Pre-test	44.253	.000	75.33	1.702
Post test	71.926	.000	77.74	1.08

CONCLUSION

Ohio's Academic Content Standards (2002) outline the science and technology knowledge, skills and dispositions for middle school students. One of the standards states that students should recognize that science and technology are interconnected. When students play Career Exploration, they are exposed to professionals who have worked on advanced technology-based projects that integrate science knowledge with technology. For example, the Ohio Academic Content Standards calls for students to learn about the weather. Little is taught about how the science of weather can be used to build technology to evaluate weather trends, climate monitoring and change. Career Exploration hosts a variety of biographies for students to read that explain how the two are integrated. Most of the biographies explain how an initial interest in a specific science topic leads to a career choice in a wide variety of science related fields. The integration of science and computer science (technology) was noted with surprise by some students. They saw computer science as technology and not related to science – this misunderstanding of the need for content within technology related fields was an interesting new discussion in the classroom.

The influence of gender was apparent in the qualitative remarks as more females than males indicated an interest in creating 'smart' medical software – taken from the biography of a female engineering Fellow. This suggests that gender may still continue to play a role in the selection of science careers.

A benchmark indicator of Ohio Science Academic Content Standards (2002) found in the Academic Content Standards PDF is to "give examples of how technological advances are influenced by scientific knowledge that can affect the quality of life." (p. 125). Many examples were given that included information about renewable energy technologies that are capable of producing clean energy, software that can be used to better prepare medical professionals, and improving drinking water by reducing the effects of pollution. Based on the comments from the case study worksheets, it appears that Career Exploration teaches the content standards in an entertaining way.

Career Exploration was designed to increase the awareness and knowledge of science careers in rural middle schools where technology capacity and connections to professional science careers are typically limited to the local physician. However, the game features many benefits outside of STEAM's local setting. Career Exploration contains biographies from people with many ethnic backgrounds as well as women who are pursuing careers in science. This diversity was utilized in the hopes that minorities and women would see these professionals as possible role models and be inspired to continue to take science courses in the future that would lead to a career in a science field.

This is imperative since past research (Jacobs, 2005; Villarejo, Barlow, Kogan, Veazey, & Sweeney, 2008) indicates that minorities and women are underrepresented in science-based careers. Career Exploration attempts to promote science literacy by presenting many successful people who are working in various science-based occupations with STEM. In addition, students enjoy seeing people whom they know inside of the game that includes the GK-12 Fellows that attend their classroom and even their middle school teachers. In low socio-economic areas, this type of virtual interaction can be used as a substitute for the students when they do not know community members with specific backgrounds related to science-based careers.

Career Exploration was limited in this particular case to presenting engineering and educational fields as it was designed with information regarding the members of the STEAM project. This could be viewed as a limitation of this game. However, the game can easily be modified to incorporate many more types of science-based careers as the biographies originate as PowerPoint slides – a common format for most people. This use of PowerPoint for creating the biographies suggests the game could be modified for many career fields.

In the current version of the game, computer science was represented significantly more than the other major engineering disciplines. However, instead of just describing similar projects from the STEAM Fellows who were computer scientists, biographies were written about a variety of issues that included; the importance of co-op partnerships, explaining of how related subjects like mathematics are used in a certain science or technology profession, or describing traits that people tend exhibit within a certain science, math, technology or engineering occupations.

Career Exploration was quite successful both in the pilot and implementation in the middle schools. The students were engaged and indicated that they had learned about a group of careers not typically known. The research concerning the use of Career Explorations continues in middle schools in the region. Career Exploration can be downloaded for free from STEAM's website (http://steam.cs.ohiou.edu). Anyone can experience the educational opportunities provided by the STEAM games freely available on STEAM's website. The games include games built within Second Life, Adobe Flash and the STEAMiE engine.

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